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Highlights of Natural Resources Management 1987



Natural Resources Programs
Natural Resources Report
National Park Service

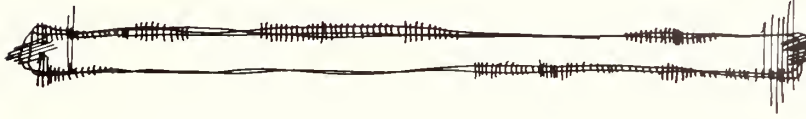


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Highlights of Natural Resources Management 1987



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HIGHLIGHTS OF NATURAL RESOURCES MANAGEMENT

A report on National Park Service natural resources management activities in 1987.

We are pleased to transmit the Highlights of Natural Resources Management report for 1987.

During 1987, the NPS research program continued its vigorous pursuit of collecting, analyzing, and synthesizing the scientific information needed for managing the natural resources of our national parks. Throughout the national park system, the focus has been on assessing park natural resources through baseline surveys, resource inventories, and monitoring activities.

Such studies and research are not only of value in assisting park natural resources management, but they contribute to the growing body of scientific knowledge concerning our natural world. Scientific studies in parks are also seen as increasingly important because they can help reveal changes occurring in ecosystems as a result of human or natural effects. National parks can serve as monitors of such changes and assist in policy, management, and planning responses. Knowledge of our park natural resources is critical to managing parks in such a way that they can be enjoyed by today's generation, while preserving them for the next.

Other resources management activities reflect the National Park Service's commitment to protecting and assisting in the recovery of threatened and endangered wildlife and plant species. Natural resource programs and plans address water resource issues, air quality issues, impacts to park resources, and community relations, as well as many other issues.

Most natural resources management projects take years to accomplish, and almost all require scientists and resource managers at the parks, the regional offices, the NPS cooperative park study units at universities throughout the country, and the Washington Office to cooperatively contribute to the long-term protection of the environment.

In carrying out its natural resources management activities, the National Park Service also works cooperatively with federal, state, and local agencies; researchers at universities, private contractors, and conservation and environmental organizations.

Only a sampling of the NPS natural resources management activities for 1987 are presented in this yearly report. The brief accounts are intended to represent the Park Service's diverse natural resources management activities. Detailed research findings are published in scientific publications. For more information on a particular natural resources project, contacts are listed.

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Threatened and Endangered Species

1



Everglades panther.

NATIONAL PARK SERVICE COMMITS TO RECOVERY OF FLORIDA PANTHER

The decline of the Florida panther (Felis concolor coryi) and its distribution has been underway since the arrival of the first Europeans. The panther, whose distribution once extended from eastern Texas eastward through Mississippi, Louisiana, Alabama, Georgia, Florida, and parts of Tennessee and South Carolina, was eliminated by early settlers at every opportunity because of potential and real losses of livestock. Given these conditions, most populations were eliminated before 1900.

The Florida panther was officially listed as a federally endangered species in 1967. Today, fewer than 50 individuals may remain in the wild. Their distribution has been greatly reduced and restricted to southern Florida. Much of their presently known distribution is within Everglades National Park and Big Cypress National Preserve. The reason why panthers still remain in southern Florida is that, until recently, much of the area was inaccessible to man and development, but this is no longer the case. The panther is rapidly losing suitable habitat. Current threats to this species include low population numbers and depressed genetic variability, increased human presence, diseases and parasites, and reduced prey base.

Since 1986 the National Park Service has made an ambitious commitment to assist in the recovery of the Florida panther. The specific objectives of Florida panther research in the NPS areas are to determine basic population parameters, behavioral and ecological requirements, and general health and genetic condition of the population.

Research is also being conducted on white-tailed deer in the Everglades because deer are the primary prey base for the panther. The objectives of this study are to (1) estimate the demographic characteristics of the deer population at different sites; (2) determine the physical condition of the deer population at different sites; (3)

estimate deer recruitment and mortality at the different sites and, where possible, relate these to predation, hunting, habitat quality, and age and physical condition of the deer; (4) determine the seasonal movement patterns of deer at the different sites in relation to habitat types, changing environmental conditions, reproductive condition and, where possible, movement caused by disturbance and predation; and (5) determine forage quality within habitat types at the different sites.

Since the beginning of the panther research Everglades biologists have captured and radiocollared six panthers (two adult females, three young females, and one young male). All six of these animals are in good physical condition. In April 1987 the one young male and one of the young females separated from their parent and established their own home ranges. The other subadult female remains with her parent.

The radio-collared panthers are tracked daily, and to date, over 1,000 locations have been recorded. The radio tracking has provided data on home range size, movement patterns, habitat use and requirements, and food habits. As a result of this study, management is considering reducing the speed limit in an effort to protect the panthers.

*Sonny Bass, Everglades National Park
Russell E. Galipeau, Jr., Southeast Regional Office*

GREAT LAKES AND ATLANTIC COAST PARKS STUDY PIPING PLOVERS

Midwest Region Plover Initiative

Since the early 1900s piping plovers (*Charadrius melodus*) have steadily declined in numbers from their breeding grounds along prairie rivers and alkali wetlands in the northern Great Plains and undisturbed beaches of the Atlantic Coast and Great Lakes. Possible causes of decline in plover numbers in these three primary regions are varied and not completely understood. In the northern Great Plains, diverted flows from prairie rivers and loss of wetlands are apparent factors. Along the Great Lakes shorelines, rising lake levels and human disturbance are cited as reasons for the disappearance of this rare shorebird.

In January 1986, the piping plover was officially listed as threatened in its northern Great Plains and Atlantic Coast breeding areas and was determined to be endangered in the Great Lakes region. Since the piping plover is presently, or was, a known breeder in several Great Lakes parks, the National Park Service is required by the Endangered Species Act of 1973, as amended, to take actions to protect this rare species and its habitat on park lands in this region.

In response to the requirements of the Endangered Species Act and to a recent initiative in the Midwest Region to survey all park rare, threatened, and endangered flora and fauna, a three-year study of the distribution, population status, and management of piping plovers in NPS Great Lakes parks was begun in May 1987. This work is being done under an interagency agreement with the Missouri Cooperative Fish and Wildlife Research Unit, U.S. Fish and Wildlife Service. The principal investigator is Dr. Mark Ryan, a member of the federal piping plover recovery team, who has previously done research on piping plover in North Dakota.

The project will look at the distribution and abundance of piping plovers in Apostle Islands, Indiana Dunes, Pictured Rocks, and Sleeping Bear Dunes national lakeshores. Also, as a part of the project, investigators will map, quantify, and evaluate the quality of nesting habitat available in these parks. The results of this research will be used to recommend management actions for protecting breeding populations of the piping plover on park lands and to evaluate the potential of using unoccupied habitat for reestablishment of breeding populations.

*Mike Van Stappen
Midwest Regional Office*



*Piping plover. Photographed by Bill Dyer for the Cornell
Laboratory of Ornithology.*

Assateague Island Plover Research

A two-year study of the piping plover, which uses the sandy beaches and wide overwash areas of Assateague Island National Seashore as one of its primary mid-Atlantic breeding areas, has recently been completed by researchers from the Virginia Polytechnic Institute (VPI) and Virginia State University. The study was limited to the NPS-owned Maryland portion of the island in 1986 but was expanded to include the Chincoteague National Wildlife Refuge portion in 1987. The study was designed to provide information on piping plover population size and breeding chronology, determine natural and man-made factors affecting nest success, and describe historical changes in habitat suitability using aerial photography.

The 1987 study results indicate a nesting success (hatchlings produced) rate of 45% for 105 nests. Most of the nest failures were due to predation by red foxes or raccoons; only one was directly related to human activity. Similar results were recorded during the 1986 breeding season. Indications are that plovers nesting on Assateague seem to be less insistent on occupying what had in the past been considered optimum nesting habitat, and more reliant on the proximity of feeding areas to nesting sites. The researchers hope to investigate this relationship more fully if funding for further study becomes available.

In 1988 the National Park Service will be sponsoring a study by researchers from the University of Maryland, Eastern Shore, to look at the relationship between piping plover and the red fox, and to determine the historical status of the red fox as a native species on Assateague Island. The VPI researchers considered predation by the red fox to be the chief factor limiting piping plover reproductive success on Assateague.

*Jack Kumer
Assateague Island National Seashore*

ENDANGERED SPECIES REINTRODUCED AT NEW RIVER GORGE

Two endangered species have found new homes at New River Gorge National River in West Virginia. A pair of peregrine falcons (Falco peregrinus anatum) were successfully hacked from a cliff near the New River Gorge bridge and 11 plants of running buffalo clover flowered a year after they were reintroduced on NPS-owned property along the New River floodplain.

The peregrine hacking program, the first in West Virginia, was a cooperative effort between the West Virginia Department of Natural Resources (DNR), the Peregrine Fund, the National Park Service, the U.S. Fish and Wildlife Service, and the land-owner. DNR officials selected the site high on the cliffs above the New River and about 1 mile from the world's longest steel arch bridge. The bridge is a roosting site for pigeons, which are an ideal food source for the raptors. The Peregrine Fund supplied three young birds and hired caregivers who stayed with the hacking box until the birds were on their own. One of the birds was injured shortly after fledging and died from infection of the wounds. The other two falcons, which were siblings, gradually learned to fly and hunt and, when last seen, were cavorting together over the thousand-foot deep gorge.

The running buffalo clover (Trifolium stoloniferum) was once common in the Ohio Valley in open woodlands and along buffalo trails. Several specimens were collected around the turn of the century. Last collected in the 1940s, running buffalo clover was thought to be extinct until a West Virginia botanist found it in 1983 along a jeep trail downstream from the park boundary. At the time only 4 plants were known to exist in the wild. Cuttings from these plants were propagated at the University of Kentucky, and during the summer of 1986, park personnel helped reintroduce 22 plants on property that had just been acquired by the National Park Service. By the summer of 1987, 11 of the plants had died, but the others had flow-

ered and were growing vigorously. The plants suffer from competition with other species and weeding is a necessity. The clover was added to the list of endangered species in June 1987. Shortly after, additional populations were discovered near the Ohio River in Kentucky and Indiana. The search for additional wild populations will continue, but right now the only running buffalo clovers growing on federally owned land are the reintroduced population at New River Gorge.

*Meg Weesner
New River Gorge National River*

RESEARCH CONTINUES ON COLORADO RARE AND ENDANGERED FISH

During 1987, research in Dinosaur National Monument continued on the Colorado rare and endangered squawfish, humpback chub, razorback sucker, and bonytail chubs.

The Colorado squawfish continue to spawn at one site on the Yampa River, which is the largest of two known spawning sites in the Upper Colorado River Basin. Flows from Flaming Gorge Dam were modified in an attempt to ensure greater survival of Age 0 fish.

A significant population of humpback chubs was documented in the Yampa River last year, and initial studies suggest that this population may be the only genetically pure population in the Upper Colorado River Basin. Other populations exhibit considerable hybridization with roundtail chubs, possibly in response to dams and subsequently altered flow regimes.

Tagging and recapture studies suggest that only about 1,000 adult razorback suckers remain in riverine habitats in the Upper Colorado River Basin. This population is located in and near Dinosaur National Monument in the Green River. All adult razorbacks are apparently older than Flaming Gorge Dam. Young-of-the-year fish

have been captured each year, but no juvenile fish have been captured in five years of study. Habitats have been significantly modified by the dam and now support populations of nonnative fish. Predation by these nonnative fish is suspected as the major cause of loss of young-of-the-year razorbacks. The U.S. Fish and Wildlife Service has captured and successfully raised young-of-the-year fish to Age 1 in offsite grow-out ponds. Efforts have been renewed to formally list the razorback on the federal endangered species list.

Bonytail chubs have probably been extirpated from monument waters. Plans are underway for three transplants of hatchery-reared bonytail chubs in the Green River at a location near the site of most recent captures. Transplants are scheduled for pre-runoff, runoff, and post-runoff periods. Telemetry radios will be implanted in all released fish to facilitate research on movements and habitat selection. Partially funded by the Park Service, the Utah Division of Wildlife Resources and the Utah State University will conduct the research.

*Steve Petersburg
Dinosaur National Monument*

PEREGRINE FALCONS RESTORED TO NATIVE RANGE ON ISLE ROYALE

Implementing the 1984 Peregrine Falcon Reestablishment Plan at Isle Royale National Park, Michigan, last year resulted in the first successful reintroduction of peregrines to NPS lands in the Midwest Region.

In the upper Midwest, peregrine falcons formerly nested on steep bluffs along the upper Mississippi River Valley, shores of Lake Superior, and on Isle Royale. Beginning in the mid-1940s, peregrines began to decline nationwide and were eventually extirpated from this region as a result of eggshell thinning and reproductive failure due to the widespread use of highly toxic organochlorine pesticides, especially DDT. This vanguard venture to restore peregrine falcons to their former native range on Isle Royale is the result of cooperative efforts between the National Park Service, The Minnesota Chapter of The Nature Conservancy, and the Department of Veterinary Biology, University of Minnesota.

Five peregrine chicks were purchased under contract from The Minnesota Chapter of The Nature Conservancy and delivered on July 15 to the park hack site on Feldtmann Ridge. The chicks, which were banded and color marked for identification, were kept in a hack box at the site and fed quail by attendants. In late July, restraining bars were removed and the immature falcons could then test their wings while still relying on food provided by the site attendants. By mid-September, all five of the young falcons were fully fledged and ready to follow their prey species south in the fall migration. The final success of this reintroduction effort will be determined in three years when these birds reach sexual maturity and are expected to return to the park to nest. Future releases of peregrine falcons are planned for Isle Royale in 1988 and 1989.

*Mike Van Stappen
Midwest Regional Office*



Peregrine falcon in Isle Royale National Park.

DINOSAUR REESTABLISHES FALCON POPULATION

In 1987 three wild peregrine falcon eyries were fostered in Dinosaur National Monument, Colorado, with nine of the ten birds successfully fledging and dispersing. Surveys located three additional occupied sites in and near the monument, and each of these sites included one immature bird. Of the five pairs that were closely observed, both birds of three pairs were banded in a pattern that indicates they were fostered in wild eyries. Eggshell thinning remains high. Fostering is again planned in 1988 to ensure adequate recruitment.

One hack site was operated in 1987. All four young were successfully fledged and dispersed. A young female was later recovered in central Utah in an emaciated condition. She was held and fed by the Utah Division of Wildlife Resources and then successfully released again.

*Steve Petersburg
Dinosaur National Monument*



Steep-walled canyon in Zion National Park.

ZION CONDUCTS THREATENED AND ENDANGERED PLANT SURVEY

Zion National Park in Utah has long been recognized as having diverse plant communities. The many steep-walled canyons create wide elevation differences, and these elevation differences coupled with varying rainfall provide Zion with a myriad of climates and microclimates. Zion contains at least four life zones. With this tremendous diversity of habitat types, it would be expected that many plant species are present in the park. Of particular interest is information on possible threatened or endangered species and under what conditions they are surviving. A contract for a sensitive plant species survey was awarded in May 1987, and a team of botanists began surveying in mid-June. The results are far beyond what was expected.

In a little over five months, 64 new taxa have been added to the park's plant list, and 4 new plant records for the state have been located in the park. Zion has nearly reached one-third of the species found in the entire state. As of November 1, 1987, the team had recorded 849 taxa. A great deal of new information has been gained from this work. Many species that were thought to be extremely limited have been located in other parts of the park. Species that were not even known to exist in this area have been found as well. Zion is waiting with anticipation for the spring flowering season when it is expected that more new species will be found.

The study will continue for two years. By the time it is concluded, Zion will have a better idea of what botanical resources it possesses and how to better monitor and protect this unique floral heritage.

*Larry L. Hays
Zion National Park*

Research and Technology  2



Crater Lake research boat.

SUBMERSIBLE ROBOT SURVEYS CRATER LAKE

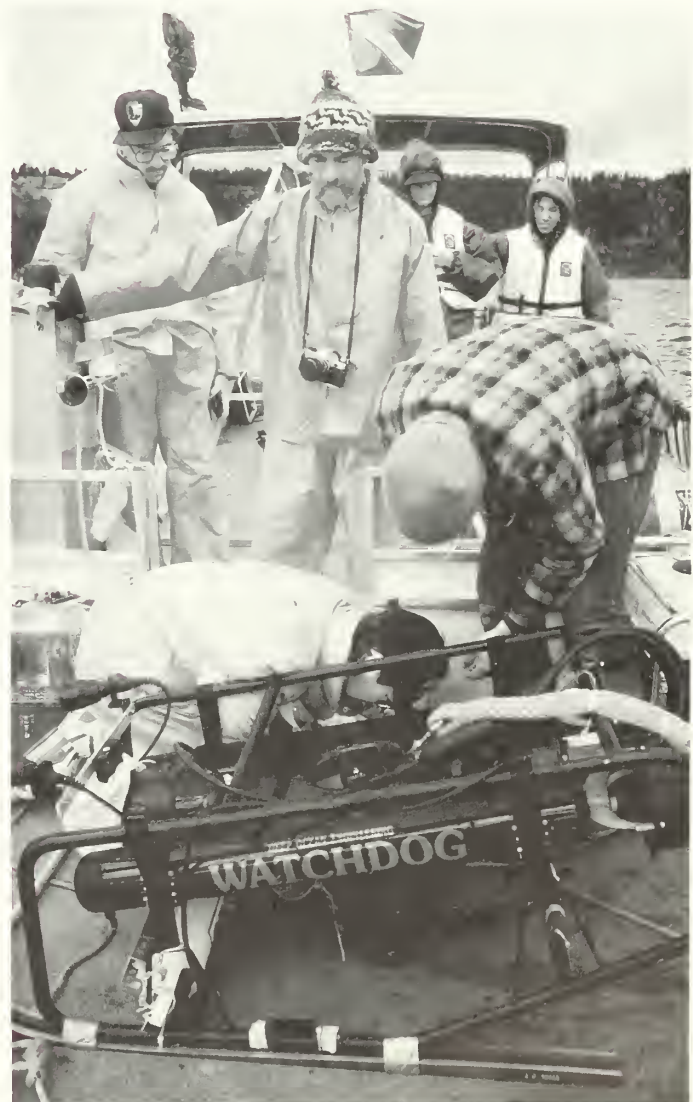
Crater Lake, the deepest lake in the United States, sits in a caldera formed by the collapse of Mount Mazama Volcano. Since the late 1800s, scientists have been interested in this deep lake, which is in Crater Lake National Park, Oregon. Through years of research scientists have speculated that hot springs or hydrothermal vents existed on the lake bottom. They had noticed that high concentrations of chemicals associated with hydrothermal fluids were present in the lake. Another piece of evidence supporting the hydrothermal vent theory was the slight increase in water temperature found on the lake bottom, although the warm vented fluid coming in contact with the cold lake water (37°F) is quickly diluted and cooled. Scientists have felt that the hydrothermal fluid may be an important factor in the lake's ecology, but despite years of lake research, no one had ever actually seen or sampled a hydrothermal vent in Crater Lake.

In 1986 Congress passed Appropriations Bill 115, listing 22 national parks (including Crater Lake) that have significant thermal features. This bill was designed to protect hydrothermal features in national parks from geothermal exploitation. In order to describe Crater Lake's thermal features adequately and determine their significance to the lake ecology, the National Park Service requested funding for a three-year research program.

The first year of research began in August 1987. Dr. Dymond and Dr. Collier, from Oregon State University's Oceanography Department, used a submersible robot to survey the southeast basin of the lake, where warm water had been recorded. The little robot sub was lowered 1,600 feet to the lake floor, and using a videocamera the robot recorded much of the lake floor to be a buff-colored fine sediment. After just two hours of searching the robot came upon an orange gravel-like sediment area which had solidified. In this area two small vents were emanating a white wispy thermal fluid.

The robot's survey will help scientists to focus in on certain areas of Crater Lake during the next two summers. In 1988 and 1989, manned submarines will be used to search the lake floor for more vents and to sample temperature, chemistry, and flow from each hydrothermal vent discovered. In addition to the sampling, a monitoring program will be established to learn the significance of the vents on the lake ecology.

*Jim Milestone
Crater Lake National Park*



Dr. Dymond and Dr. Collier with robot on Crater Lake.

LYME DISEASE RESEARCH RESULTS APPLIED WIDELY

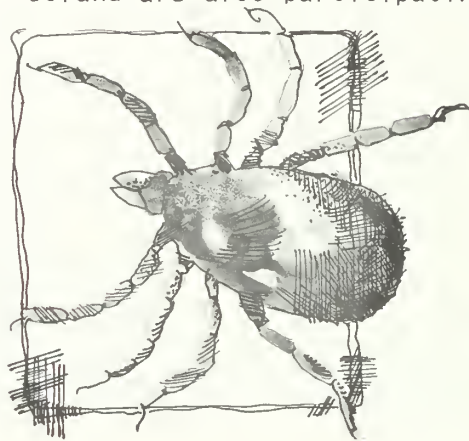
First described in 1975, Lyme disease is an illness that is transmitted to people by tick bites. Although not all ticks carry the disease, local infection rates can be quite high in some tick species.

A characteristic rash or lesion develops a few days to a few weeks after the bite of an infected tick. Unfortunately, some patients never get a rash, making diagnosis difficult. At about this time, flu-like symptoms may appear along with headache, stiff neck, fever, muscle aches, and/or general malaise. One of the heavier known rates of infection occurs within the staff of Fire Island National Seashore in the state of New York. In 1985, then Superintendent Hauptman (now at Acadia National Park) convened an action group to solve the range of problems this new development posed for staff and visitor alike.

The Office of Scientific Studies, North Atlantic Region, conducted park-specific Lyme disease research, focusing first on the deer tick life cycle and the distribution and infection rates of ticks (with the causative spirochete bacterium). This work (by Dr. Howard Ginsberg at Rutgers) was coordinated with deer population and distribution studies (by Dr. Mark Sayre, University of Massachusetts, and Allan O'Connell, resource manager, Fire Island National Seashore) to understand the role of deer in distribution and maintenance of disease risk. The results are available and are being published widely in the scientific literature. In 1987 Dr. Ginsberg traveled at the request of other regions to advise superintendents, resource managers, and interpreters and to provide practical actions that parks and visitors can take to avoid infection and to detect symptoms. This becomes very important since it is now becoming clear that early treatment is very effective, but lack of treatment can lead to severe problems including central nervous system disorders. Infected ticks were also found as far north as Acadia National Park in Maine. Park-

specific and servicewide brochures have been developed with the help of Dr. Ginsberg.

In 1987 we also designed, with Gary Johnston's assistance from the NPS Washington Office, a study to test a new, simple, and safe method for controlling immature ticks on white-footed mice in developed areas near campgrounds and required occupancy housing. Communities on Fire Island are also participating.



*Michael Soukup
North Atlantic
Regional Office*

UPDATE ON BAT-COUNTING SYSTEM

The NPS bat-counting system, previously described in the 1986 Highlights report, has been perfected and extensively tested during the 1987 field season. The apparatus has been coupled to a night-vision scope and has resulted in the ability to photograph in near-total darkness. The counting system has been used to quantify the number of bats at Bandelier National Monument and at Carlsbad Caverns National Park in New Mexico. During the summer of 1988 the apparatus will be made available to various researchers and agencies. Plans are made to photograph (count) the bats at Eagle Creek Cave in Arizona, which contains several million Brazilian Free-tailed bats. New plans are being made to count exit flights of Indiana bats in Missouri for the U.S. Fish and Wildlife Service.

*Milford Fletcher
Southwest Regional Office*



Wildlife biologist Layne Adams processes an immobilized wolf in Gates of the Arctic National Park and Preserve.

WOLF RESEARCH IN THE ARCTIC CAN BE COLD BUSINESS

Below zero temperatures are not good for much, but in March 1987 a team of biologists from the National Park Service and the Alaska Department of Fish and Game took advantage of the cold weather to initiate research on the status and population ecology of wolves in Gates of the Arctic National Park and Preserve, Alaska. When an Arctic high-pressure system, with temperatures hovering in the -10° to -30° range, clear skies, and no winds, parked over the central Brooks Range, the biologists used the excellent tracking conditions to locate, capture, and radiocollar 30 wolves in 16 packs. These conditions are highly unusual for the northern portion of Gates of the Arctic and allowed the team to radiocollar wolves in areas where high winds and little snow are the norm.

The goals of the wolf research are to determine the status of the wolf population; assess population dynamics including

productivity, survival, and dispersal; determine the influence of subsistence harvest on the population; and investigate relationships between wolves and their prey.

To date, researchers have documented a successful pup-rearing season with litters averaging 4.5 pups, determined that the wolves have a stable land tenure system even though they use the highly migratory Western Arctic Caribou Herd as an important food source, and documented dispersal movements for 2 young male wolves of approximately 320 miles into the northern Yukon Territory of Canada.

This research project is slated to continue for two years. Information from this project will allow managers to assess the effects of subsistence harvest and other factors on the wolves of the central Brooks Range.

*Layne G. Adams
Alaska Regional Office*

RESEARCH TECHNIQUES IDENTIFY AIR POLLUTION SOURCES

Air pollution impairs visibility to some extent in every NPS unit where monitoring has been conducted. The major objectives of visibility research in the Air Quality Division have been to establish the condition of the visibility resource, identify the pollutants causing visibility impairment, identify the specific sources or source regions of these pollutants, and evaluate the effectiveness of emission reductions for improving visibility conditions.

Measurements from several parks are used to determine common geographical patterns of pollutant concentrations and the weather associated with each pattern. Other statistical techniques using wind data determine the probability that a source area may be contributing to air pollution which causes impairment, primarily fine sulfates. The source areas for high concentrations of fine sulfate particles at Grand Canyon National Park, Arizona, and Shenandoah National Park, Virginia, are shown in the top (opposite page) illustration. The contour lines give the relative importance of the source areas causing the high sulfate episodes. At Grand Canyon National Park, for instance, southern California is four times (80/20) as likely to be a source of high sulfate as west Texas.

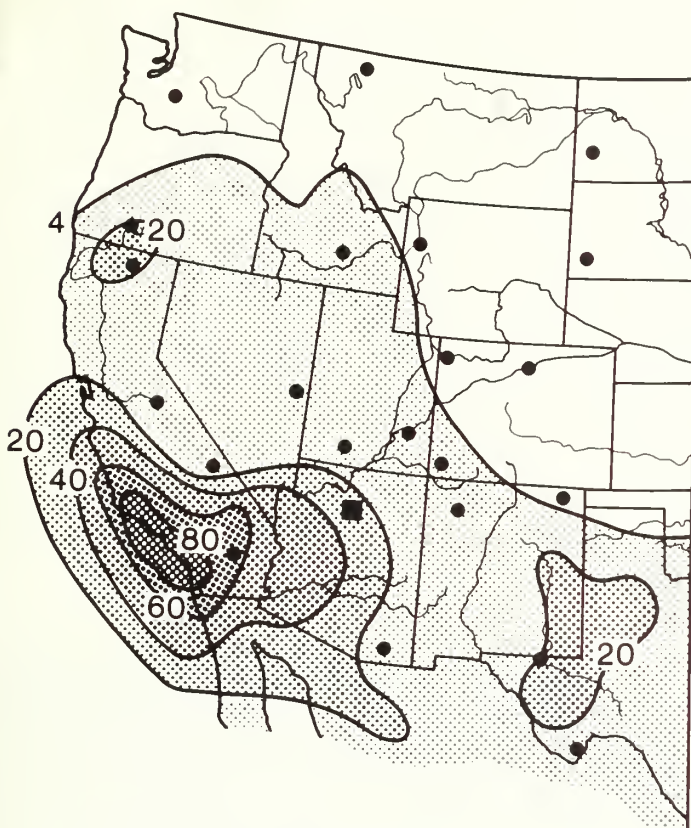
Similar analyses have shown that the visibility in Big Bend National Park, Texas, is affected by air masses transporting pollutants primarily from northeastern Mexico and the Texas Gulf Coast. Big Bend receives the heaviest sulfate loadings and has the most reduced average visibility of any class I park area in the intermountain West and Southwest. Pollutants from these two areas are also affecting national parks as far away as the Grand Canyon.

Once the air pollution source areas are determined, researchers use another technique to calculate the contribution of each source to the measured pollutant

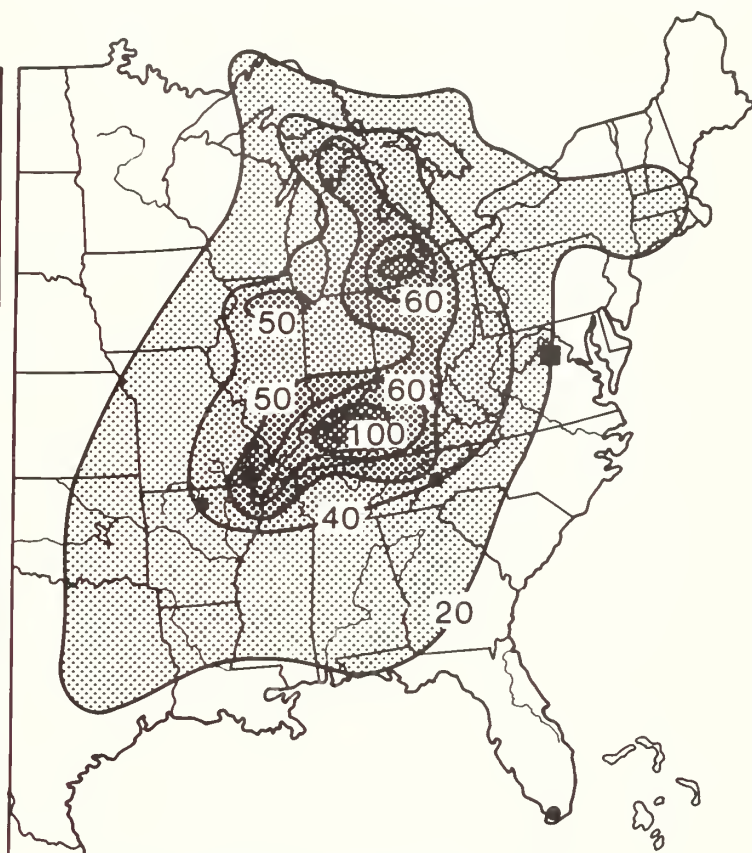
concentration. One such technique looks at the amount of time the air resided in each region before arriving at the park. Results for a five-year time period at Grand Canyon are shown in the bottom (opposite page) illustration. Emissions from Los Angeles and San Diego together are responsible for over one-third of the sulfur measured at the Grand Canyon. Other important sources include metal-smelting and power-generating facilities in the Southwest.

Another technique is being developed to calculate the actual amount of pollutants emitted by each source or source region contributing to visibility impairment. With this new technique, the Air Quality Division will be able to predict how variations in source strength would change the pollutant levels at NPS units. This analysis will provide the information to evaluate the effectiveness of emission control strategies proposed by state and federal agencies.

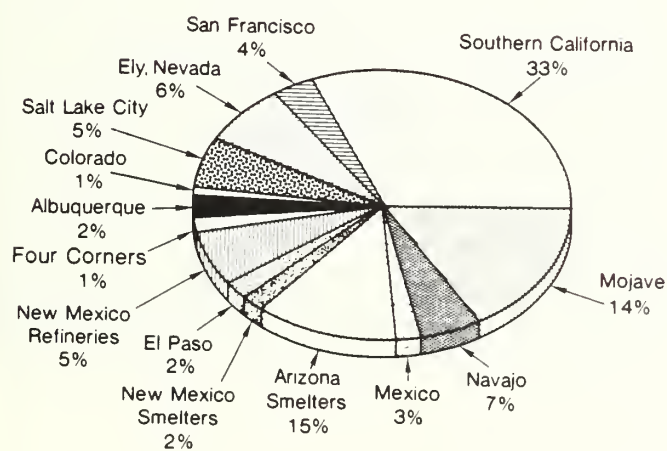
*Bill Malm
Air Quality Division*



Grand Canyon National Park



Shenandoah National Park

Sources of Sulfates at
Grand Canyon National Park

FATE OF CARIBOU CALVES STUDIED IN DENALI

The caribou herd of Denali National Park and Preserve, Alaska, declined from a population of more than 15,000 caribou in the 1930s to approximately 1,500 caribou in the late 1970s. Other caribou herds throughout Alaska also experienced declines, but few declined to the same degree and most have recovered substantially since. The Denali herd, however, has remained at a low level. Unlike other Alaska caribou herds, the Denali herd has been affected little by harvest and is used by a relatively unmanaged and natural complement of large predators. This situation provides an excellent opportunity to investigate caribou population dynamics and predator relationships in a natural system.

One characteristic of the Denali caribou herd at its present population level has been relatively poor survival of calves. In 1984 research was initiated to investigate the causes and extent of neonatal mortality. Each May since 1984 biologists have captured caribou calves in the first few days following their birth and instrumented them with mortality-sensing radio collars. Once instrumented, the calves are located by radiotelemetry on a daily basis through that month, when most of the mortality occurs.

To date, 225 calves have been successfully radiocollared. Of those, 40% died during May, with grizzly bears being the cause of 47% of those deaths. Wolves have accounted for 29% of the deaths. Calves were also preyed upon by golden eagles and wolverine. Only one mortality, a drowning in 1986, has been attributed to a cause other than predation. Calves that survive through May have a high likelihood of surviving to their first birthday.

Wolf/caribou relationships (in conjunction with ongoing wolf research), reproductive biology of caribou cows at low population levels, and population status and trends assessments are also being investigated. This research program allows park managers to assess the status of the caribou population and its relationship with other large mammal populations in Denali. At the same time, the information is providing an important comparison for managing harvested caribou and predator populations throughout Alaska and northern Canada.

*Layne G. Adams
Alaska Regional Office*



Brad Shults radiocollars a newborn caribou calf in Denali National Park and Preserve.

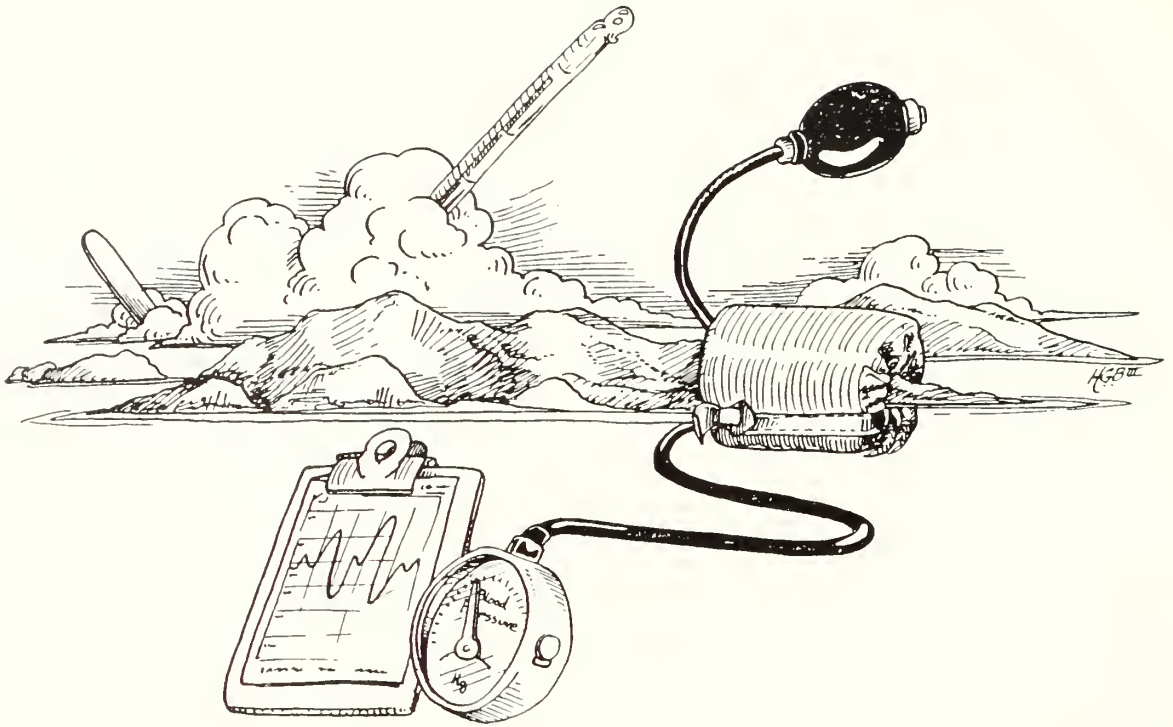
RESTORING RAZED RESIDENTIAL SITES IN INDIANA DUNES

Studies of plant succession in old residential sites at Indiana Dunes National Lakeshore have shown that the type of man-caused disturbance can significantly affect succession rates and potentially affect species composition of a site for at least a century. Typical residential land uses (drive, garden, building site, and lawn) were mapped for 30 razed residential sites, ranging from 3-11 years old, using historic aerial photos and ground surveys. Vegetation and soils were sampled within each past land use at each site. Plant species composition, richness, and aboveground biomass varied greatly among past land uses. Similarity in species composition among past land uses decreased over time. Significant variation of soil nutrients and structure was also found among past land uses; however, variation in soils decreased over time.

The results of this research, other related research, and ecological theory are being used to formulate prescriptions for site preparation to encourage rapid succession towards the surrounding vegetation in razed residential sites. The major factors believed to be responsible for the differences in vegetation among past land uses and to modify succession rates and direction are soil characteristics and the presence of exotic species. Methods to modify soil characteristics and to eliminate problem exotics are now being tested.

*Ronald D. Hiebert
Indiana Dunes National Lakeshore*

Inventory and Monitoring Programs



CHANNEL ISLANDS ASSESSES ECOSYSTEM HEALTH

What are an ecosystem's vital signs? How do you know if a system is healthy? Ecosystems influenced by modern civilization, just like people, need regular checkups and health maintenance organizations (HMO). At Channel Islands National Park, California, the population dynamics of 450 selected marine and terrestrial species are used to assess ecosystem health, determine normal limits of variation, and define management options for remedial action.

The primary advantage of using plant and animal populations as indicators of ecosystem health is that they integrate a wide variety of environmental influences such as disturbance, predation, competition, and nutrient availability. Populations express their responses to these influences as changes in such readily measured parameters as abundance, distribution, age structure, and mortality rates. Other parameters of population dynamics, such as reproductive efforts and growth rates, are sensitive measures of subtle chronic stress that can provide early warnings of impending disaster. Measurement and interpretation of these parameters are relatively straightforward and amenable to management. Information on population age structure, mortality, and growth also permit reasonable projections of system health into the near-term future, just as a physician can describe the prognosis and treatment for an overweight, hypertensive patient.

The strategy for developing an ecosystem health maintenance organization (HMO) at Channel Islands is outlined in the step-down diagram shown on the following page. Research scientists selected appropriate species to monitor, designed and tested monitoring protocols, and prepared handbooks documenting procedures for annual "checkups." Resource managers, acting as family physicians for park ecosystems, now monitor system health, diagnose abnormalities, prescribe treatments, and evaluate treatment efficacy. They also

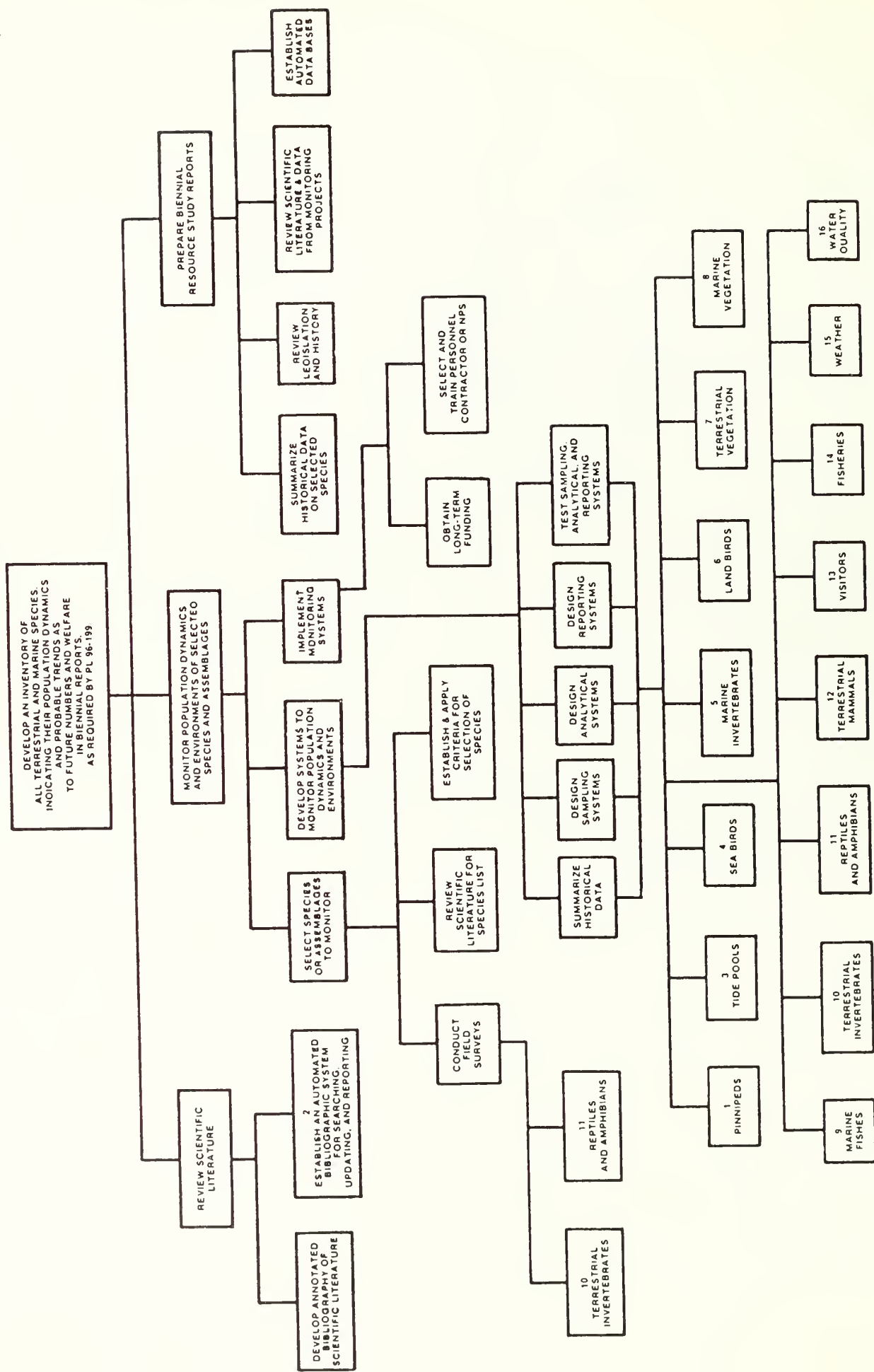
identify situations that require additional research. Research scientists analyze clinical information gathered by resource physicians to establish normal limits of variability and identify patterns of change indicative of human impact.

This ecological health monitoring program is a cooperative effort. Marine mammal populations in the park are tracked by scientists from the National Marine Fisheries Service. The U.S. Fish and Wildlife Service provides funds for sea bird monitoring from the endangered species program for California brown pelicans. The California Department of Fish and Game assists NPS personnel with intertidal abalone and kelp forest monitoring. NPS scientists monitor terrestrial invertebrate, reptile, bird, mammal, and plant population dynamics and provide program oversight and coordination. Standard weather, sea temperature, and limited air and water pollutant data are also collected regularly in cooperation with a variety of county, state, and federal agencies.

Although in its infancy, the monitoring program has already diagnosed potential difficulties and suggested remedial actions which are now being tested. For example, visitor impacts on tide pools from trampling, specimen collecting, and rock turning were suspected after the first three years of monitoring. Experimental research confirmed that trampling could cause the observed impacts. The park's interpretive staff, with a student volunteer and minimal assistance from park scientists, produced a seven-minute videotape describing three simple steps visitors can take to reduce their impact on tide pools. The tape will be shown to all concession-transported tide pool visitors (5-10,000 per year), and the monitoring program will continue to evaluate resource conditions. If impacts persist, additional measures will be prescribed and tested.

STEP-DOWN PLAN FOR NATURAL RESOURCES MONITORING AT CHANNEL ISLANDS NATIONAL PARK, CALIFORNIA

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NUMBERS INDICATE PRIORITY OF PROJECTS ESTABLISHED BY SUPERINTENDENT, CHIEF AND NATURAL SCIENCE DIVISION, WFO



Park rangers J.T. Reynolds (left) and Craig Johnson log diver activity during kelp forest monitoring at Channel Islands National Park.

The universality of this approach to assessing ecosystem health and developing long-term monitoring programs as diagnostic tools is being tested in other park settings. Last year, a similar step-down plan was developed to address systemwide threats and organize ecosystem research at Organ Pipe Cactus National Monument in southern Arizona. The Channel Islands intertidal monitoring protocols were used to initiate a similar program at Olympic National Park in Washington and to plan visitor impact studies and management actions at Cabrillo National Monument and Gulf of the Farallones National Marine Sanctuary in California.

The Channel Islands model was also used by a Director's Task Force, headed by Alaska

Regional Director Boyd Evison, to develop NPS policies and strategies for natural resources inventory and monitoring. The task force recognized that inventory and monitoring are fundamental elements of the NPS mission. As parks become more and more influenced by the civilized world, monitoring programs will become increasingly important to the successful management of those areas. We encourage all parks to initiate population dynamics monitoring as quickly as possible because we have found it to be the most effective management tool for assessing ecosystem health.

*Gary E. Davis/William L. Halverson
Channel Islands National Park*

A TALE OF TWO RIVERS: RESOURCE INVENTORIES AT ST. CROIX AND ZION

Resource inventory has become an increasingly important process in preserving and protecting national park natural resources. Meaningful inventories should have aspects of acquiring, managing, analyzing, and interpreting information on park resources. Too often in the past, resource inventories have been little more than lists of organisms and locations found with no provision for establishing the ecological basis for management implications. Ecological paradigms are networks of hypotheses that offer ready structures for the collection of environmental data, interpretation of results, and enumeration of management options within the framework of resource inventories.

The River Continuum Concept is the paradigm currently being applied to two river system aquatic resource inventories at St. Croix National Scenic Riverway in Wisconsin and Minnesota and the Virgin River in and above Zion National Park in Utah. The River Continuum Concept describes in a general fashion how the physical, chemical, and biological characteristics change as streams combine to become larger and turn into rivers. This ecological paradigm provides an integrated set of hypotheses that represent current scientific thinking on the biology of streams and rivers as well as providing NPS management with information on specific management problems.

Resource managers at St. Croix are concerned that changes in land use outside the NPS river corridor will affect changes in the natural resources of the St. Croix River. A sampling program was carried out this past year to establish baseline conditions for key water quality variables and community level biological indicators in the main stem river as well as how key tributaries were presently affecting the river. Differences and changes in large-scale land use affect critical variables such as the available phosphorus, nitrogen, and different size classes of detrital

organic carbon particles in the river. These changes in turn affect the structure and function of biological communities in the river which can be assessed by applying appropriate biological indicators at the community level of organization. By using the River Continuum Concept, inventory and monitoring can be integrated with management concerns on how land use outside the river corridor may change environmental quality in the main corridor of the St. Croix National Scenic Riverway.

The natural resources inventory of the Virgin River in Zion National Park is designed to establish the hydrological basis for the biological community present in the river. The River Continuum Concept was employed to select variables and sampling stations that can be used in a qualitative way to predict changes in the aquatic community due to changes in flow with construction of dams proposed upstream from the park. More quantitative predictions of resource change due to alterations in the flow regime of this river will be predicted by the integration of the data collected in the River Continuum Inventory and use of the Instream Habitat Modeling Techniques developed by the U.S. Fish and Wildlife Service.

*Terence P. Boyle
Water Resources Division*

GYPSY MOTHS THREATEN ECOSYSTEM DYNAMICS IN SHENANDOAH

Gypsy moth larva are voracious hardwood tree defoliators capable of completely stripping the foliage from thousands of acres of park forests each year. In 1986, 1,300 acres were defoliated, and this figure increased to 7,000 acres in 1987. The prognosis for 1988 is another large increase in the areas defoliated.

Impacts from this defoliation are severe and widespread. Species of oaks (*Quercus* sp.) make up an average of 85% of the vegetation in much of the park. Defoliation-induced mortality to these species may exceed 60%, triggering a profound change in forest ecosystem dynamics.

In an effort to better understand, manage, and possibly predict future impacts and changes, the park has initiated a wide range of monitoring and research programs which include (1) a large and comprehensive long-term ecological monitoring system (LTEMS) of permanent study plots; (2) a gypsy moth population monitoring system; (3) a three-year research project to determine the impacts of defoliation on the park's high black bear population; (4) a hazard rating and risk assessment geographic information system (GIS) program; and (5) a public education program to explain park programs and interpret environmental changes.

Although undoubtedly many park visitors will view the coming environmental changes with disgust, the long-term effects may prove not to be all bad. On the positive side is increased ecosystem diversity which will mean a wider variety of flowering plants and wildlife. Through the research and monitoring programs, park resource managers hope to gain a better understanding of the problem and how to best protect sensitive resources from unacceptable levels of change.

*John Karish
Mid-Atlantic Regional Office*

MONITORING LARGE MAMMAL POPULATIONS IN DENALI

Populations of caribou, moose, and Dall sheep have fluctuated widely since Denali National Park and Preserve was first established in 1917. To understand what changes are occurring and provide information on population dynamics essential for various related studies, such as moose-habitat relationships, wolf predation, and recreation traffic effects on wildlife movements, distribution, and behavior, the Denali park staff and the Alaska Regional Office are cooperating in a program of inventories and surveys. Estimating large mammal populations has been difficult due to methodology problems, but recent advances by Alaska Department of Fish and Game and others have now made it possible to conduct reliable surveys in interior Alaska. Presently park, region, and independent researchers conduct some surveys annually, and others at intervals of five years or more.

Portions of the park and preserve are surveyed each year to estimate moose numbers, sex and age composition, recruitment, distribution, and trend in population change, using a stratified random sampling technique. The Denali moose population is currently estimated at 2,284, with wide differences in density. Caribou population size and composition are done by both direct counts and photo-census. The most recent estimate is 2,600 in the Denali caribou herd. Dall sheep are surveyed annually for composition and recruitment in a small sample of their range. Every five years or more a complete helicopter census is attempted but is sometimes weathered out. The last complete census was 1981 when 2,184 sheep were counted.

*John Dolle-Molle
Denali National Park and Preserve*

BASELINE BIOLOGICAL SURVEYS IN ANIAKCHAK CALDERA

Aniakchak National Monument and Preserve, located about 450 miles southwest of Anchorage on the Alaska Peninsula, is one of the most remote and least visited units in the national park system. Fewer than 100 people/year visit the area. Although established by Congress for its unique volcanic features, Aniakchak also contains significant examples of plant and animal succession. In an effort to begin documenting, monitoring, and better understanding the processes involved in these changes, an interdisciplinary team of biologists conducted baseline surveys in Aniakchak Caldera during three weeks in July 1987. These surveys represent the first quantitative biological investigations for the area.

Aniakchak Caldera is a 6-mile wide and 2,500-foot deep, ash-filled bowl. Still volcanically active, the Caldera last erupted in 1931. The interior of the Caldera is subject to violent windstorms, rain, overcast skies, and cold weather. Other than the team's three-week stay, only one party has stayed longer than three to four days in the Caldera.

During the survey, 145 vascular plants were identified in the Caldera; 138 were collected for the park and University of Alaska Museum herbariums. About one-fifth of the plants were range extensions. Over 100 bryophytes and lichens were also collected. Vegetative communities were delineated, mapped, and quantitatively sampled for species abundance, composition, and diversity. Permanent photo-points were established in an effort to document plant succession.

Mammals and birds were surveyed in representative Caldera habitats using a variety of observational and capture techniques. Of the mammals surveyed, 10 were identified in the Caldera; specimens of each of the 6 small mammal species found were collected and sent to the University of Alaska Museum on long-term loan.

Representing 15 families, 38 bird species were sighted and 42% of the species were confirmed breeding in the Caldera.

Only two fish species, sockeye salmon and dolly varden, were collected in the 716 acre Surprise Lake (located in the north-east corner of the Caldera) during beach seining, gill netting, electro-shocking, and minnow trapping. The biologists also mapped the depth contours of the lake, took water discharge measurements, monitored water chemistry parameters, and collected aquatic invertebrate and zooplankton samples.

Because of the short growing season, patchiness of vegetation, dominance of early seral successional stages, and continued substrate instability, the Caldera ecosystem is fragile and quite susceptible to human alteration. In an effort to better understand what impacts the research team (and other visitors and researchers in the future) might be having, the team quantitatively measured physical and environmental features of the base camp at the beginning and end of the field season. In addition, a photo-point was established at this site to further assist in the long-term analysis.

Data collected during this past summer's biological reconnaissance will serve as a foundation for future monitoring and studying of the dynamic changes occurring in the Caldera. We plan to establish permanent vegetation plots, including the site of the 1931 volcanic eruption. Examination of terrestrial invertebrates and soil-nutrient processes is also planned. A two-year intensive limnological study of Surprise Lake will begin in 1988.

*David Manski
Aniakchak National Monument and Preserve*



Glass Lake in Rocky Mountain National Park.

PRECIPITATION CHEMISTRY IN ROCKY MOUNTAIN NATIONAL PARK

Analyses of seven years of precipitation chemistry at Rocky Mountain National Park in Colorado showed two interesting trends. The first is a pronounced seasonality in precipitation acidity, with summers having more acidic rain and higher concentration of sulfate and nitrate, the man-produced anions which cause acidic deposition. Deposition of acidity, sulfate, and nitrate is also highest in the summer, and winter-time depositions do not reflect much pollution influence at all. This relieves concern that current pollutant buildup in the snow pack could harm aquatic life when snowmelt pulses through aquatic ecosystems by causing an "acid stock."

We have also found the major anion associated with acidic rain or snow events to be nitrate, although the acidity in some storms was dominated by sulfate. This is

an indication that the Front Range urban corridor east of Rocky Mountain National Park is a primary source of acidic pollutants. Major sources of nitrate are nitrogen oxide emissions from vehicles, and they are not suspected to travel long distances in the atmosphere before reentering terrestrial ecosystems.

While precipitation has been shown to exhibit seasonal trends of acidity, summer values are still not very acid. They are, in fact, above the threshold values where damaging effects occur in sensitive ecosystems. So while aquatic ecosystems in Rocky Mountain National Park remain extremely vulnerable to the influence of acidic deposition, there is no evidence that precipitation is yet acidic enough to cause environmental degradation.

*Jill Baron
Water Resources Division*

KATMAI LONG-TERM VEGETATION STUDY AT VALLEY OF TEN THOUSAND SMOKES

The 1912 eruption of Novarupta Volcano, Alaska, ranks as one of the major eruptions during historical times. In one area, more than 40 square miles were buried in hot ash and pumice deposits that measured up to 700 feet deep. This awesome sight was discovered in 1916 by Robert F. Griggs, leader of six National Geographic Society sponsored expeditions into the area between 1915 and 1930. Steam and other hot gases escaping through countless fumaroles from the hot mass led Griggs to name this amazing area the Valley of Ten Thousand Smokes.

Griggs reported that in 1917, with the exception of moss and algae starting to grow around some of the mild vents, plant life was absent in the Valley of Ten Thousand Smokes. In 1919 he discovered that fumarole activity had declined slightly while moss and "blue-green" algae had increased to form dense carpets around some of the fumaroles, sometimes visible from a mile's distance. By 1930 Griggs and his party found that in addition to algae and mosses, dense mats of liverworts (Cephaloziella byssacea and Lophozia bicrenatus) up to one-half-inch thick were growing on ash in a number of mildly steaming areas that had been bare in 1919. The only other plants found in the Valley in 1930 were a few isolated clumps of bluejoint (Calamagrostis canadensis) growing near Novarupta.

A study of the biological resources at Katmai National Park and Preserve was conducted during the summers of 1953-54 by Victor H. Cahalane who at the time was chief biologist for the National Park Service. By 1953 most of the fumaroles had died and the lower plant forms had all but disappeared due to loss of favorable microhabitat. On the other hand, seed plants such as sedges, rushes, and grasses had increased dramatically in shallow depressions where moisture collected. In 1954 Cahalane established six approximately one-eighth acre "permanent" vegetation

plots in areas representative of the Valley. Apparently no fumaroles, active or dead, were located within any of the plots. Plants within each plot were identified, counted, and mapped. Plants in plot A consisted of 367 individuals of tickle grass (Agrostis geminata) and 4 individuals of the alpine wood rush (Luzula arcuata). Five species of vascular plants were present in plot B: approximately 473 individual plants of alpine wood rush, about 309 individuals of bluejoint, 86 individuals of arctic blue grass (Poa arctica), 83 plants of mountain sorrel (Oxyria digyna), and 31 individuals of Mertens sedge (Carex mertensii). Unidentified species of mosses were also present in two small areas of the plot. Plot E contained approximately 250 plants of Mertens sedge and a small patch of an unidentified species of moss. No plant life of any kind was found on or in the vicinity of plots C, D, and F.

In September 1987 three of the Cahalane plots were located and examined, 75 years after the eruption and formation of the Valley. Seven species of vascular plants were growing in plot A. Tickle grass and alpine wood rush, the only species present in 1954, had increased to approximately 3,000 and 660 individuals respectively. Other species and numbers of individuals were snow pearlwort (Sagina intermedia), 1,983; bluegrass (Poa lanata), 877; arctic bluegrass, 28; mountain sorrel, 28; dwarf fireweed (Epilobium latifolium), 13; and countless individuals of the moss Pogonatum dentatum. Total coverage contributed by all species present in plot A was about 1%. Random plots were used to sample plot B because the increase in total vegetation since 1954 made it impractical to census the entire macroplot. Alpine wood rush expanded into some areas formerly occupied by mountain sorrel and increased in density by about five-fold since 1954. Although bluejoint decreased slightly in density, many clumps were in the same locations mapped 33 years earlier. Mertens sedge had all but disappeared, and arctic bluegrass and mountain sorrel were no longer present in the plot. Establishment of tickle grass



Plot B from southwest corner with Mount Griggs in background, Valley of Ten Thousand Smokes, Katmai National Park and Preserve.

bluegrass, and Barclay willow (Salix barclayi) in the plot occurred since 1954. Tickle grass formed a fairly uniform cover over the entire plot with the exception of eroded areas. Two as yet unidentified species of moss and a lichen covered approximately 3% of the plot. Total density on plot B increased from 0.2 to 3.8 plants per square foot between 1954 and 1987. Total vegetative cover for the plot

was 21%. Plot F was still void of vegetation. No vegetation was apparent in the general vicinity of the reported locations for plots C and D; however, we were unable to locate either of these plots or plot E, because it appears that the markers for these plots are no longer in place.

*Gary M. Ahlstrand
Alaska Regional Office*



Tundra swans at Noatak National Preserve.

SWANS SERVE AS INDICATOR SPECIES OF ENVIRONMENTAL CHANGE IN NOATAK

The first tundra swan survey of the Noatak National Preserve, Alaska, was completed by park staff last summer, with a total of 596 swans counted. The results indicated that the lower Noatak River drainage serves as a more important breeding area for swans than the National Park Service or the U.S. Fish and Wildlife Service (FWS) previously thought.

The survey was conducted according to the FWS Trumpeter and Tundra Swan Survey Protocol. The NPS-collected data will be incorporated into the FWS Migratory Bird Management Division's Alaska Tundra Swan Status Report. By using a standardized

methodology both agencies are able to benefit from the other's survey efforts.

Tundra swans can be used as an "indicator species" of environmental change. Research has shown tundra swans to be extremely sensitive to aircraft disturbance and habitat degradation. Reduced brood size, lower brood survivorship, and abandonment of nesting areas have been related to the above causes. Annual documentation of swan numbers, productivity, and nesting range will provide an early indication of adverse changes in swan populations and the harsh but fragile environment they inhabit.

*Lee Anne Ayres
Northwest Alaska Areas, Kotzebue*

Cooperative Research Activities



Feral pig damage to oak woodland in Pinnacles National Monument.

IMPACT STUDY YIELDS PARK MANAGEMENT BENEFITS

The potential impact of feral pigs on the integrity of the native ecosystems at Pinnacles National Monument prompted the Western Region in 1983 to fund a multidiscipline study of this problem. The NPS Cooperative Park Studies Unit (CPSU) at the University of California, Davis, was assigned the task of organizing and recruiting a team of researchers from the National Park Service, the university, and the private sectors to address potential feral pig impacts on various components of the park's flora and fauna. This research effort, now in the final stages of completion, is an example of how expertise from many branches, both within and outside the Park Service, can interact in a large-scale research project to provide much needed baseline information for a park.

Before initiating any field work, the NPS Remote Sensing Branch (RSB), Geographic Information System Division, was contracted to provide a complete vegetation map for the park. Up-to-date aerial photographs were made of the area through a cooperative agreement with the Environmental Protection Agency. These were then photointerpreted with approximate boundaries drawn for all major vegetation types identified within the park. This map was then ground-checked by RSB and Pinnacles staff.

During the vegetation mapping period, CPSU personnel conducted extensive literature searches on all major categories of physical and biological entities that were to be studied in the park. This effort resulted in the discovery that a complete survey of amphibians and reptiles had previously been done in the area, and this aspect of the study would not have to be undertaken, thereby saving scarce research dollars. The extensive literature base also provided a foundation from which each of the principal investigators could launch their respective research efforts.

Before initiating field data collection, permanent stations were established throughout the park. These 70 plus stations were chosen to represent all major vegetation types within the park, with at least 10 stations located in each type. Care was taken to make all locations easily accessible. Each station was permanently marked with stakes and tree tags, photographs taken from the central point in 4 cardinal directions, and the locations identified on a master map in the park. Each of the principal investigators were then directed to conduct their resource inventory work at these previously identified sites. In this manner, investigators would have available to them the resource inventory information from all groups of plants and animals under study. Integration and correlation of plant, animal, and bird data at each study site increase the power of the baseline study to detect feral pig impacts to flora and fauna over time. Additionally, continuity will be provided by directing future studies in the park to these permanent sites. The park has identified in its Resource Management Plan the need to implement a long-term monitoring program to compliment the baseline study.

The results of this cooperative research effort have proven beneficial to Pinnacles National Monument. The park now has complete inventories of birds, mammals, reptiles, amphibians, and vegetation. Numerous spin-offs have also resulted from this effort. The investigators who worked on the birds and mammals updated checklists of their respective organisms. These were published by the Southwestern Parks Natural History Association and are now available to park visitors. The bird survey was expanded to include a more detailed study on raptors and included recommendations for the reintroduction of two endangered species that had previously been extirpated from the park. Another aspect of the raptor study dealt with the impact of climbers (a high visitor use of the park), and this has resulted in the formulation of a Rock Climbing Management Plan.

The park itself has also contributed to these spinoff efforts. Park funds have been provided to extend baseline vegetation research to several less common plant communities and to a description of the summer annual flora. The park also supports an annual raptor nesting survey and oak tree mast inventory premised on research recommendations.

In an effort to more widely disseminate this research information, the CPSU/UC has encouraged publication in its Technical Report Series. At this time, four of the resource inventory studies have been published (avifauna survey, mammal survey, raptor survey, rock-climber impacts), and a detailed vegetation survey will be published in early 1988. These documents have provided Pinnacles National Monument with basic resources information that is often difficult to obtain for small park areas. The project shows what a small park can do with "creative financing" of limited funds (seed money for the project was less than \$35,000), if proper planning is undertaken before the research effort and if expertise is drawn from varied sources within and outside the Park Service. The results of this cooperative effort will serve as a basis from which other park areas can begin planning their much needed and long awaited resource inventory studies.

*Charles van Riper III
NPS Cooperative Park Studies Unit
University of California, Davis*

BIOLOGICAL CONTROL OF LEAFY SPURGE IN THEODORE ROOSEVELT

In cooperation with North Dakota State University, U.S. Department of Agriculture, and North Dakota Department of Agriculture, Theodore Roosevelt National Park has begun a program to study the use of two insects as biological controls on the exotic plant, leafy spurge. The infestation of leafy spurge, a European native, has increased approximately 25-fold since it was initially discovered in the park in the early 1970s.

The two insects, a flea beetle (Apthona flava) and a gall-forming midge (Bayeria capitigenia), are both native to Europe where they are coevolved with leafy spurge. They have undergone extensive laboratory testing by the U.S. Department of Agriculture in both Europe and the United States, and have been approved for further testing in field trials. The laboratory and limited field testing have shown that these two species pose no threat to Northern Plains ecosystems. With these data in mind, a few additional field test sites have been established. The site in Theodore Roosevelt National Park was selected because access to and manipulation of the experiment can be closely regulated, and agricultural influences such as grazing and herbicide use in the area are tightly controlled.

Adult flea beetles feed on the foliage of leafy spurge, and females burrow into the roots to deposit eggs. The larvae, after hatching, then burrow through the roots thereby severely disrupting root functions of the plant. The midge is a delicate fly which lays its eggs on the growing tips of the leafy spurge plant. The leaves around the growing tip then form a tight gall around the eggs, preventing the plant from flowering, and thereby reducing seed production.

Two caged colonies of each species were established in the park in July 1987. Of primary interest to the researchers is to study the ability of the insects to reduce

the density of spurge stands, control the spread of spurge, ascertain if any previously undiscovered environmental competition develops, and determine the insect species' ability to survive and adapt to the Northern Plains environment.

Depending on the ability of these insects to adapt to the Northern Plains climate and barring any unforeseen environmental difficulties, the park hopes to eventually use them in our integrated pest management program for leafy spurge to supplement and hopefully reduce the use of chemical and mechanical treatments.

*Jeff Bradybaugh
Theodore Roosevelt National Park*

NPS NORTHWEST ALASKA AREAS GRIZZLY BEAR STUDY

In 1986 a population assessment of grizzly bears (*Ursus arctos*) in relation to human exploitation and mining development in the Noatak National Preserve, Cape Krusenstern National Monument, and adjacent nonfederal lands was initiated. Grizzly bear research in the Northwest Alaska Areas (Noatak National Preserve, Cape Krusenstern National Monument, and Kobuk Valley National Park) is an example of cooperative efforts between the National Park Service and the Alaska Department of Fish and Game (ADFG). The project is jointly funded and both agencies provide logistical support and have personnel directly involved with the project. ADFG Wildlife Research Biologist Warren Ballard is directing the research.

Alaska has the largest remaining populations of brown/grizzly bears in the United States. Due to the remote nature of much of the bear's habitat, bear populations have required little intervention from resource managers. The picture, however, is changing in Alaska because resource development has recently become technically and economically feasible in the state's more remote areas.

A 2,600-square-mile study area was selected due to plans for constructing a road and developing a lead/zinc mine, the Red Dog mine, in the core of the area. Also concern over increasing hunting pressure and confrontations between bears and local fisherman in the area contributed to its selection. Even with the seemingly vast size of our park units in Alaska, they still do not encompass complete ecosystems. For management objectives to succeed, the cooperative efforts of all landowners is required. Because managers and biologists are required to make decisions and predictions of development impacts on bears, sound biological data must be available to them.



Processing and attaching a radio collar to a grizzly bear in Alaska.

In late May and early June 1986, 47 grizzly bears were captured, of which 31 were radiocollared. During the spring of 1987 an intensive population survey was conducted, concentrating on a 720-square-mile area within the study area. A technique for estimating wildlife populations called "capture-recapture" was used. Using fixed-wing aircraft, five pilot and observer teams located bears in the study area. Bears marked in 1986 were identified by the teams, and a helicopter crew was called in to mark and collar the unmarked bears. With the assistance of a sixth aircraft the number of collared bears within the study area was determined. At the end of each day the number of marked and unmarked bears observed along with the number of collared bears within the study area was entered into a computer, and a population estimate with a corresponding confidence interval was obtained. This information told researchers how much further sampling they needed to do in order to have the desired statistical confidence. With successive days of search effort, the population estimate stabilized and the confidence interval decrease.

A density estimate of 1 bear per 14 square miles for the 720-square-mile census area was obtained based on a population estimate of 44, with a 90% confidence interval of 37 to 55. This was higher than area managers expected. On the north slope of the Brooks Range grizzly bear population densities are reported to be as low as 1 bear per 33 square miles, while at the other end of the spectrum bears in the southeast occur at densities of up to 1 per square mile.

Last year the movements of radio-collared bears have been monitored biweekly. Movement patterns have provided researchers with insights on when certain food resources such as caribou, moose, spawning fish, and vegetation are of importance to the bears and where bears in this study go to obtain them.

Presently, brown bears in this region of Alaska are hunted by sport and subsistence hunters during the fall. Other human-caused mortality results from cases where bears are killed in defense of life or property. Although the loss of bears due to these causes are of concern, developing a large lead/zinc mine in the study area with an accompanying road and port site will be the foremost challenge to wildlife and resource managers in the future. Loss of habitat and increased human contact have contributed to the loss of brown bear populations in the lower 48 states. Staff in the Northwest Alaska Areas Office see this as an opportunity to take advantage of all the painful lessons we have learned in the past regarding bears and people. Preserving healthy bear populations in Alaska, as in the lower 48 states, will depend on the cooperative efforts of researchers, managers, and developers.

The ADFG and NPS cooperative study will continue through 1990. The study's emphasis will shift from obtaining population numbers to gaining a more detailed knowledge of movement patterns of bears in the vicinity of the Red Dog mine and of seasonal habitat use. Interpretive programs for mining personnel and the surrounding villages will be an important part of the Park Service's role in this project.

*Lee Anne Ayres
Northwest Alaska Areas, Kotzebue*

LANDFILL AFFECTING ACADIA NATURAL RESOURCE CLOSED

Worcester landfill on Mount Desert Island has been used by the residents of the island for depositing domestic refuse since the 1930s. In the late 1970s residents in the vicinity of Marshall Brook in Acadia National Park, Maine, reported a reduction in the normally productive brook trout fishery.

Preliminary investigations indicated that Worcester landfill was leaching un-ionized ammonia and perhaps severely affecting the aquatic life in Marshall Brook. A cooperative study involving the Office of Scientific Studies, North Atlantic Region; the University of Maine; the WASO Water Resources Division; and the Regional EPA Laboratory in Lexington, Massachusetts, addressed the impact that the landfill leachate had on the biological community in the stream.

The landfill leachate on the upper portion of the Marshall Brook watershed was directly affecting the aquatic life of the stream. High levels of ammonia, sufficient to cause acute mortality to aquatic biota in laboratory toxicity tests, were found in ditches draining the landfill. Toxicity tests involving serial dilutions of the leachate and control water from Marshall Brook showed reduction in survival and reproduction in laboratory tests with fish and invertebrates. Biological community studies in Marshall Brook revealed a reduction in the density of diatoms in the periphyton community and an increase in the species richness and diversity, an increase in the macroinvertebrate density with a reduction in the diversity, and an extirpation of the brook trout and American eel with a possible replacement by the four-spined stickleback in the stream reach immediately downstream from the leachate.

Worcester landfill was closed in 1987, and mitigation procedures are currently under way to reduce the amount of toxic leachate impact to Marshall Brook.

*Terence P. Boyle, Water Resources Division
Michael Soukup, North Atlantic Regional Office*

A VICTORY FOR BUFFALO NATIONAL RIVER AND COMMUNITY

A substantial controversy broke out in Pindall, Arkansas, when a permit was granted by the state of Arkansas to construct a landfill in the karst area of Buffalo National River in northcentral Arkansas. Local citizens and the National Park Service were parties to extensive hearings opposing this landfill because dye-tracing studies showed that a major spring within the park, which feeds the Buffalo River, would be contaminated by leachates. The central issue was whether the permit should have been issued, based on the extensive data showing the contamination potential. After several months of deliberation, the permit was rescinded. Although the permitting process is not yet complete, this appears to be a victory for neighbors and communities near Buffalo River, as well as for the park.

*Milford Fletcher
Southwest Regional Office*

COMMUNITY RESPONSE TO FEDERAL PRESENCE

Last year research was conducted in the Mid-Atlantic Region to examine the evolving relationships between the National Park Service and local communities within the Upper Delaware River Valley of Pennsylvania and New York and within or near the boundaries of the New River Gorge National River in southern West Virginia. The Upper Delaware was designated as a Scenic and Recreational River in 1978. As a result of negotiations between local groups and the federal government, the terms of the 1978 legislation called for a cooperative arrangement under which land use regulations would substitute for large-scale federal land acquisition in the Valley. Despite this approach, a prolonged conflict occurred between local residents and groups and the National Park Service, and this conflict resulted in the termination of an initial planning process carried out to implement the law. A second planning process built around the concept of a local body to act as an intermediary between the federal government and local communities was also fraught with bitter conflict. The 1978 legislation, which designated the New River Gorge National River, contains provisions to protect the integrity of existing local communities in the area and the interests of local residential landowners. Thus, in these two cases, the National Park Service is more in the position of developing closer relationships with local community groups than is usually the case in more conventional national parks.

The data collected for these studies include historical information about the areas, a demographic profile of the populations, and a chronology of events relating to the establishments of the federal presence. The main body of data for the study was derived from in-depth personal interviews with a wide variety of local residents conducted by the researcher.

The analysis of the community responses at the Upper Delaware suggests the conflict was the result of a number of factors. These include early negative impressions created by certain actions and statements by federal planners and managers, a lack of ties between some groups of local residents and those involved in planning for and managing the area, power struggles between entities representing the federal presence, complexities introduced by simultaneous consideration of both land and water use issues, and the subsequent emergence of very effective anti-NPS mobilization agents.

The results from the New River study indicate that the NPS managers have been unusually successful in developing ties with and positive perceptions on the part of a wide range of local residents and groups. This is attributed, in part, to sensitivity of NPS personnel to local values, customs, and viewpoints. However, there does exist a need to develop stronger ties and better communications with certain local groups, most notably landowners in the more remote communities and traditional river and riverbank users.

Recommendations concerning the future of NPS community relations in the Delaware Valley suggest the need for an even-handed approach and a period of trust building as the area enters into a new phase of operations. With respect to future designations of similar areas, the Upper Delaware has provided a number of object lessons related to difficulties faced by both sides when a formal organization such as the National Park Service is required to work closely with local communities. The need for the development of a positive image, mutual understandings, and trust with the entire spectrum of local residents are identified.

For New River Gorge, recommendations are made that agency managers continue to devote energy to maintaining and further developing ties with local groups despite the increasing emphasis on building an operational presence. Strategies mostly involving face-to-face interactions with residents are identified for accomplishing this end.

*John Karish
Mid-Atlantic Regional Office*

INTERAGENCY WOLF STUDY IN NORTHWEST ALASKA AREAS

In the spring of 1987, 11 wolves, belonging to 5 different packs, were radio-collared as part of an interagency study involving the NPS Northwest Alaska Areas, Alaska Department of Fish and Game, and U.S. Fish and Wildlife Service. Wolves inhabit all three of the park units, Noatak National Preserve, Cape Krusenstern National Monument, and Kobuk Valley National Park. The wolves collared in this study range in Noatak and Kobuk Valley.

The study's objectives are to develop a wolf census technique, document the demography of wolves in northwest Alaska, and gain an understanding of their movement patterns in relation to the Western Arctic Caribou Herd. The status of the wolf population is unknown and current census methods may not be adequate for effective management of wolves.

The movements of one wolf are being monitored via the French Argas-NASA satellite. Instead of the standard radio collar a transmitter that could be tracked by the satellite was used. This tracking method is allowing Alaskan biologists to acquire data on animals previously unavailable due to the 24-hour darkness and other logistical constraints. The satellite passes over Alaska up to 12 times a day providing the biologist with information on an animal's movements via a computer console. Not only is the amount of information greatly increased but the risks related to aerial tracking for the biologist are greatly reduced.

This past summer the three agencies monitored the movements of the collared wolves and inspected the wolves den sites. Plans for 1988 are to collar 12 more wolves in preparing for the population census and to continue monitoring pack movements.

*Lee Anne Ayres
Northwest Alaska Areas, Kotzebue*

Resource Initiatives and Programs





Great Blue Heron in Curecanti National Recreation Area.

HERONS ON THE GUNNISON

Although riparian habitat comprises only a small part of the high, mountainous relief of western Colorado, this habitat is biologically very productive. The Neversink Area, about 5 miles west of Gunnison, Colorado, and partially within the boundaries of Curecanti National Recreation Area, is a broad floodplain with the braided Gunnison River meandering through hay meadows and clusters of cottonwoods and willows. For the past 15 spring and summer seasons a colony of Great Blue Herons and Black-crowned Night-Herons numbering approximately 80 birds have nested here. For the previous 30 years, they nested a few miles to the east, but as the town of Gunnison expanded, human disturbance caused the birds to abandon those sites and relocate to the present location.

This may be the last nest site possibility for the colony, as west of the Neversink Area the Gunnison River enters a deep narrow gorge and then opens into a broad river plain that is now flooded by Blue Mesa Reservoir. Suitable isolated nesting habitat needed by these colonial nesting birds is not found west of the present rookery. Much of the success of the Neversink Rookery can be attributed to ranching activities that have been ongoing in the immediate area for decades. The open meadows cut by irrigation canals have created buffer zones that have kept all but low impact ranching activities and an occasional fisherman from the area. Ironically, current grazing practices may ultimately doom the rookery. Unrestricted grazing cattle, especially in the spring, have eaten and trampled most emerging woody vegetation growth for many years. The result is almost a single-age class of cottonwood trees which serve as the nest locations for both species of herons. As these older trees mature and die there will not be other generations to replace them.

This past summer Curecanti resource management staff constructed three enclosures (approximately 22 by 33 feet) within the gazing areas. Two enclosures were planted with 60 young cottonwood trees. Fertilizer tablets and rabbit guards were provided and the survival rate has been high. Next spring trees will be planted in the third enclosure. A narrow corridor along the south branch of the river is also planned for protection to provide additional riparian development. This approach should allow for the success of new cottonwoods, willows, and other vegetation, but still allow grazing activities under special permit. The gazing ensures the open meadows and irrigation canals favored as feeding areas by the herons and of course excludes many human activities that would be detrimental to the continued success of the rookery. At this time the adjacent private lands also used by the herons for courting, breeding, nesting, and feeding activities are owned by an individual concerned with the rookery's future. A change in ownership and land use practices could also be the end for the rookery.

By continuing resource enhancement efforts and agreements with private landowners we may ensure that Curecanti National Recreation Area remains attractive to the Great Blue Heron, the Black-crowned Night-Herons, and other components of this ecosystem.

*Wayne H. Valentine
Curecanti National Recreation Area*



Herons nesting in cottonwoods and willows.

USING STATE REGULATORY PROCESSES PROTECTS PARK RESOURCES

As a result of a public notice in the local newspaper, the staff of Chickasaw National Recreation Area learned of the application of a catfish farm to discharge waste from a farming and slaughtering operation into Buckhorn Creek, a tributary of Lake of the Arbuckles, the central focus of recreation and visitation in Oklahoma's only unit of the national park system. The state's water quality standards state that "no degradation shall be allowed in waters which constitute an outstanding resource or in waters of exceptional recreational or ecological significance. These include water bodies located in National and State parks...." Because of the state standards and the park's concern for potential adverse effects if the permit application were to be granted, the park asked for assistance from the Water Resources Division.

The fish farm had operated previously, but without a state wastewater discharge permit, with some apparently adverse consequences to the water in the national recreation area. The park staff stated that the permitting process itself had resulted in changes to the operating practices at the fish farm, many of which appeared to be resulting in greater protection of park resources.

The Water Resources Division and the park staff testified before the Oklahoma Water Resources Board on the fish farm's permit application, stressing the special protection that Chickasaw merits under both state and federal law. We asked that the permit be conditioned to require monitoring of discharges and that a conditional, rather than full-term, permit be issued until the fish farm could demonstrate that there would be no adverse effects to the park.

The board's final decision took many of the Park Service's concerns into account. The permit requires monitoring of all discharges, prohibits discharges from the ponds between July 1 and September 30, and limits discharges from the fish-holding tanks. The National Park Service's participation in the state regulatory process successfully influenced the outcome of the proceedings and resulted in enhanced protection of Chickasaw's resources.

*Barbara West, Water Resources Division
Jack Linahan/Tom Taylor, Chickasaw
National Recreation Area*

MOUNT RAINIER DEVELOPS WATER RESOURCES MANAGEMENT PROGRAM

During 1985-87, a water resources management program was developed for Mount Rainier National Park in Washington. Existing data on park water resources was summarized, and vegetation and rock types of each watershed were described. Long-term monitoring sites were established on 16 streams and rivers, 2 hot springs, and 1 cold spring. Baseline water chemistry, bacteriological, and macroinvertebrate data was gathered at these sites. A software program, WATER Q, was developed for storage and analysis of this data. In addition, several backcountry streams were sampled for Giardia and coliform bacteria. All water resources (watersheds, streams, lakes, and springs) were cataloged and mapped for use in the park's GIS program. Lastly, a Water Resources Management Plan containing 13 project statements was written and approved.

*Cat Hawkins
Mount Rainier National Park*



Old road looking northeast in area vegetated by blackbrush in Canyonlands National Park.

SOUTHEASTERN UTAH PARKS DEVELOP RECLAMATION PLAN

Before their establishment as NPS units, Arches and Canyonlands national parks were open to and used for mining exploration and development. These activities left close to 100 miles of road scars and numerous mines and drill pads throughout the parks that have yet to recover naturally. This slow recovery is due to soils which are shallow and low in nutrients as well as the xeric nature of the climate. During 1987 resource management staff initiated the development of a plan for reclaiming disturbed sites in these NPS units.

The long-term goal of reclamation efforts is to return all disturbed lands to a natural ecological state comparable to those areas in the parks that have received little or no human-related use. While the

reclamation efforts focus on vegetation rehabilitation, it is expected that fauna recovery will occur as species from adjacent undisturbed sites expand into reclaimed areas.

The reclamation plan, presently in draft form, includes an inventory of all areas devoid of vegetation due to past human disturbance. Documentation for each site is composed of a detailed characterization of soils, vegetation in and around the site, size, aspect, local climate, distance to water, wildlife, visibility, degree of disturbance, and vulnerability to further degradation due to erosion or invasion of exotic species. Photographs of the sites further document site conditions, and a map of site locations is planned for inclusion on the parks' GIS.

Prescriptions for reclaiming the disturbed sites are being developed, thereby providing the basis for planning the supply, equipment, and labor needs. Recontouring, soil treatments, soil stabilization, seed and seedling recommendations, watering needs, labor and equipment requirements, and monitoring of effectiveness are all addressed in the site reclamation prescriptions.

Based on site descriptions and prescriptions, priorities will be set to address the most critical areas first. The criteria used for setting priorities include visibility to visitors, vulnerability of sites to erosion or invasion of exotic species, the likelihood of natural recovery, probability of success of the reclamation activity, and whether the site is a critical habitat for wildlife or sensitive plant species.

To ensure high quality and public support, the draft plan will be circulated to individuals in the research community, the National Park Service, and the public with knowledge and interest in this program. When the reclamation plan for the southeastern Utah parks is completed, it will provide guidance for obtaining funds and addressing this overwhelming problem in a systematic, scientifically sound, and cost-effective manner. Anyone interested in reviewing the draft plan, please contact Canyonlands National Park.

*Kate Kitchell/Larry Thomas
Canyonlands National Park*

WATER RESOURCE THREATS DATABASE

Over the past several years, the number of park units experiencing water resource problems from external influences has increased dramatically. In 1986, more than 200 of the 343 units of the national park system confronted actual or potential water resource issues related to external influences.

Water-related problems include water quality degradation, alterations of natural flow patterns, and ground-water contamination. Many units may simultaneously face a variety of several complex hydrological issues at one time.

During 1987 the Water Resources Division (WRD) used WRD files, NPS COMMON database, survey information provided to the Washington Office by park and regional personnel, and information provided by the National Parks and Conservation Association to develop a specialized and expanded database of threats affecting water resources of NPS units.

To date, initial entries for over 400 water resource threats have been catalogued in a manner that water resource issues can be categorized by activity (watershed development, mining/energy extraction, agricultural/forestry activity), geographical area (park, region), responsible party, and water resource affected. In addition, each entry includes a brief description of the threat summarizing what is known and actions that are being planned or implemented in response to the threat.

At this time WRD staff is working with park and regional personnel to complete this database, and to provide quality control so that this database can be used by the Washington Office, the Denver Service Center, and regional and park personnel as a source of information in water resources planning and management activities.

*Dan Kimball
Water Resources Division*

NORTH CASCADES INITIATES COMPREHENSIVE HIGH LAKES STUDY

Approximately 240 natural lakes are in the North Cascades National Park Service Complex, Washington. Many of these lakes were stocked with fish before and since park establishment in 1968. All of the lakes were naturally fish free but certainly not barren of life. They were complex aquatic ecosystems of algae, zooplankton, and bottom fauna. The effects of the introduction of fish to these systems is poorly understood and not well documented. In an effort to gain an understanding of these effects, North Cascades, in cooperation with the NPS Cooperative Park Studies Unit at Oregon State University, has prepared a review of scientific literature related to the effects of fish introductions on aquatic systems. That annotated bibliography will be available in the spring of 1988.

In addition, a study design is being prepared to evaluate the role of fish in lake communities and thereby determine the effects of fish stocking on naturally fish-free lakes in the North Cascades. A lake classification system has been developed that characterizes lakes by ecosystem similarities such as geology, slope, aspect, watershed, vegetation, elevation, surface area, and depth. These and other factors will be used to compare lakes of similar characteristics for field studies. Field activities such as ground truthing, verification of the classification system, and lake sampling are expected to begin with Natural Resources Preservation funding in 1989. The information will be used to develop a comprehensive high lake and recreational fisheries management environmental assessment and program for North Cascades. The classification system and the information derived on the effects of fish stocking will be valuable to other areas managing mountain lakes.

*Jon Jarvis
North Cascades National Park Service Complex*

OLYMPIC NATIONAL PARK DEVELOPS MOUNTAIN GOAT MANAGEMENT PLAN

The mountain goat (*Oreamnos americanus*) was introduced in the Olympics in 1925, 13 years before Olympic National Park in Washington was established. From less than a dozen individuals in the late 1920s, there are now 1,200 on the Olympic Peninsula, 1,000 of which reside within the park.

Effects of an increasing population were noted in the 1960s, but research did not begin in earnest until the late 1970s. Following a series of public meetings in 1981, an experimental management program was conducted. Various methods of capture techniques were tried and effects on plant composition and accelerated erosion were measured. Peer reviews on research were completed in early 1986.

A draft environmental assessment was completed and a series of public meetings scheduled in the fall of 1987. The environmental assessment discusses findings of the experimental management program and related research, and outlines several alternate courses of action. The discussion is broken into what to do and how to go about solving the problem. Discussions were held with Washington Department of Wildlife and Olympic National Forest officials. The park's preferred alternative (the what to) is to eliminate goats in the core and to control numbers on the periphery. The preferred methods (the how to) are to use live-capture techniques for at least three years, and then if necessary, to shoot remaining individuals while continuing live-capture efforts. All live-captured animals would be transplanted to native ranges off the Olympic Peninsula through the Washington Department of Wildlife.

A final program will be announced in early 1988, with an action program starting as early as the summer of 1988.

*Donald L. Jackson
Olympic National Park*

WARNING SYSTEM FOR HAZARDOUS RIVER CONDITIONS: CHESAPEAKE AND OHIO CANAL

To reduce accidental drowning in the vicinity of Great Falls of the Potomac, the National Park Service, in conjunction with the Interstate Commission on the Potomac River Basin and the National Weather Service, has established a prototype warning system for Chesapeake and Ohio Canal National Historic Park. This system will alert park river safety personnel to imminent hazardous conditions. These conditions occur throughout the year, but are most dangerous during the spring and summer seasons when visitors to the park venture into the waters of the Potomac River.

Statistical analysis indicated that the majority of deaths occur when the stage of the Potomac River is between 3.5 and 5.0 feet at Little Falls gaging station downstream of the area of occurrence in the Great Falls vicinity. These stages are below backfull and, therefore, the situation is a "low flow" rather than "high flow" (flood) concern. The drownings seem to result from circumstances related to relatively small but rapid changes in river stage (e.g., the visitor becomes trapped on an island when a relatively safe side channel becomes hazardous due to velocity and depth increased with increase in the stage of the main channel). The system is to prevent loss of life due to land-based recreational use of the area during hazardous conditions by providing the needed time for the park to prevent access during such events.

The real-time warning system is known as the Enhanced Limited Automatic Remote Collection (ELARC) system. The system uses hardware prepared for the National Weather Service, existing U.S. Geological Survey and U.S. Army Corps of Engineers gaging stations, and NPS-established stations, and software prepared by the Interstate Commission on the Potomac River Basin specifically for the National Park Service. The system will be networked next year so that the George Washington Memorial Parkway

will also receive the warning being provided. The system also has potential for being expanded to high flows (floods) and providing timely information to all parks adjacent to the Potomac River as well as the National Capital Regional Office.

*William Reed
Water Resources Division*

IMPACTS OF BACKCOUNTRY CAMPING IN MID-ATLANTIC REGION

Expanding backcountry recreational use in national parks is resulting in significant resource damage and has prompted a concern that we may be "loving" our national parks to death. Recreational use of park lands inevitably leaves an imprint on natural environments intended for preservation. Resource impacts associated with backcountry camping along rivers were recently studied in three parks of the Mid-Atlantic Region: Upper Delaware Scenic and Recreational River, New York/Pennsylvania; Delaware Water Gap National Recreation Area, New Jersey/Pennsylvania; and the New River Gorge National River, West Virginia.

This study documented and evaluated impacts such as the trampling and loss of vegetative ground cover, alteration of plant composition, damage to trees and exposure of roots, loss of shrubs and tree reproduction, pulverization and loss of soil organic horizons, and erosion and compaction of soil. All study sites experienced pronounced impact to trees, groundcover vegetation, and soils, in comparison with measurements taken on neighboring undisturbed controls. At all three park units, exposure of soil was extensive due to the trampling and removal of fragile understory herbs and frequent flooding, which remove loose surface organic matter.

The nature and magnitude of impacts in these riparian forests were quite similar to those reported in wilderness areas in the mountainous western states and northern

Minnesota, despite more favorable growing conditions. The characteristic of these campsites that is different is their ability to recover from impact. Favorable growing conditions and fertile soils are reflected more in high resilience than in high resistance to damage. The nature of the general relationship between amount of impact and amount of use is also comparable to that found in other studies. High use sites were more heavily impacted than low use sites, but differences were small when compared with differences in amount of use.

Effective impact management programs must be based on accurate information about the nature, severity, and distribution of impacts; how impacts are related to environmental factors such as vegetation, soil, and landform types; how impacts are related to different types and amounts of use; and how impacts are changing over time. This research was designed to address these information needs and has contributed to a better understanding of the relationships between the recreational use of park resources and the resultant ecological changes. Research results were evaluated to document use/impact relationships for varied ecosystem types, develop campsite selection and design criteria, improve site management and rehabilitation techniques, improve minimum impact education messages, and develop appropriate visitor regulations.

Jeffrey Marion
Mid-Atlantic Regional Office

SOUTHWEST REGION VERIFIES NATIONAL NATURAL LANDMARKS

Approximately 75% of the 34 designated National Natural Landmarks in the Southwest Region were visited during 1987. This was to verify their status and to determine, first hand, any threats which may jeopardize the natural integrity for which each site was recognized. Also, 10 potential National Natural Landmarks sites have been evaluated by NPS resources management specialists, scientific personnel, and contract researchers.

Milford Fletcher
Southwest Regional Office

NATURAL RESOURCE DATA MANAGEMENT IN PACIFIC NORTHWEST REGION

The proper management of the natural and cultural resources of parks is in large measure predicated on a park's ability to have access to and use information appropriate for the task. Unfortunately, recent surveys have shown that most park files are poorly organized, making it difficult to know what information is available to address a specific issue. Many parks are overwhelmed by the amount of research and monitoring data that have been collected over the years, and they often lack the personnel needed to organize these data. Other parks are frustrated by a lack of knowledge of proper techniques to organize and code data, and by a lack of understanding of the types of computer hardware and software that is useful in managing data. The broad aim of this project is to provide solutions to some of these problems. The specific objectives of this project are as follows:

1. Systematically locate all of the studies dealing with the natural and cultural resources of the individual parks in the Pacific Northwest Region and organize and summarize the key characteristics of these studies in a microcomputer database.
2. Develop a prototype geographic information system for two parks in the region.

The project has been underway for about six months. We have developed draft databases for North Cascades, San Juan Island National Historical Park, and Whitman Mission National Historic Site, all in the state of Washington. Current efforts are being directed at Mount Rainier. In North Cascades we recorded over 900 studies in the database. The project uses dBASE III+ as the database manager. We are now in the process of developing a series of easy to use menu-driven computer programs that will allow one to search on any of the 33 information fields or combinations thereof contained in the database. Examples of

these fields are the specific park location of the study including UTM coordinates, investigators doing the work, dates of the study, study description, keywords describing the work, and related resource management plan element. Several fields contain information that keys the study to elements in the Natural Resource Assessment projects contained in COMMON.

Our aim in the project is to provide every park in the region with a complete computerized resource database plus copies of the databases of all other parks and a set of programs designed to search, edit, and update the databases. Our GIS effort will occur over the next two years and will be based on the assumptions that (1) most parks are generally frustrated with their inability to use GIS technology because they do not know where to begin, lack the funds to purchase the necessary equipment, and do not know what equipment to buy and (2) until parks have hands-on access to the hardware and the database, GIS databases are not going to be used in parks. In dealing with these issues, this project will first attempt to provide a method for parks to follow in organizing data in a manner appropriate for inclusion in a GIS. It will also attempt to develop hardware and software recommendations appropriate for the various parks, particularly those which lack the funds for major hardware acquisition.

*R. Gerald Wright
NPS Cooperative Park Studies Unit
University of Idaho*

COLORADO WATER COURT RECOGNIZES INSTREAM FLOWS

In October 1987 a Colorado water court judge signed the final decree transferring three historic irrigation water rights in Rocky Mountain National Park to instream flow uses. Instream flow uses would maintain an adequate water level for outdoor recreation, aesthetics, and wildlife and fish maintenance and propagation in three tributaries and the North Fork of the Colorado River. Before this decree, the state of Colorado only recognized instream flow rights if they were obtained by the Colorado Water Conservation Board. Federal agencies and other private parties could not perfect instream flows for environmental values.

Originally, the three irrigation water rights were attached to land acquired by Rocky Mountain National Park. In 1984 these water rights appeared on a list, prepared by Colorado Water Division No. 5, showing water rights that the state of Colorado recommended for abandonment because they were not being used. The National Park Service protested inclusion of the rights on the abandonment list and worked with the state to recognize the beneficial use of the water rights for park purposes. If the state had denied the National Park Service's objection, these water rights could have been lost to developmental interests, resulting in the loss of important instream flow values. The water rights had early appropriation dates, and the National Park Service produced evidence showing that the water had been used for irrigation since the early 1900s, before the Park Service's purchase of the land and water rights.

The state of Colorado noted that the water was no longer being used for irrigation but agreed to let the National Park Service retain the water rights if a change of use was filed. The state also agreed to allow the instream flow uses as long as the water was only used within Rocky Mountain National Park.

The Colorado water court's decision in this case is a major accomplishment for the National Park Service and means that other courts may soon recognize the importance of granting instream flow water rights for federal agencies whose major responsibilities involve protecting natural resources and wildlife.

*Pat Larson
Water Resources Division*

BIOLOGICAL DIVERSITY PROGRAM

Conserving biological diversity globally, nationally, and locally has moved to the forefront of environmental issues. As manager of one of the nation's premier protected-area systems, the National Park Service has a major role in maintaining the biological diversity of our country. In the fall of 1986, the Director of the National Park Service asked a special task force, chaired by Dr. Christine Schonewald-Cox of the University of California (NPS/CPSU), to review that role and discuss ways that the Park Service could better meet the challenge. The task force's report, submitted in March 1987, together with the deliberation of a workshop held in May 1988, will form the basis for an NPS plan for research on and management of the biological diversity in our care. A plan for servicewide interpretation of biological diversity was developed in the spring of 1988 by a task group chaired by Dick Cunningham, Western Region, Chief of Interpretation. Meanwhile, several biodiversity projects funded by the Washington Office moved forward during 1987.

In anticipation of the 1989 interpretive initiative on this subject, Mike Whatley, interpretive specialist at Cape Cod National Seashore, was detailed for three months to Natural Resources-Washington to write a brochure on biological diversity for distribution in parks. His manuscript is being reviewed and revised and is slated for publication during 1988. A contractor at Ohio State University developed a questionnaire on current park interpretive programs and information and media needs related to biological diversity, and began surveying and evaluating existing materials on this subject.

Because the national park system contains numerous historic orchards, a three-year project was launched to assess and recommend ways to protect these important genetic resources. Researchers at the University of Massachusetts, in cooperation with the North Atlantic Regional Office,

will develop an automated database from a servicewide inventory of orchards, provide taxonomic identifications, evaluate the commercial importance of these historic stocks, and recommend management alternatives for their conservation and propagation. During 1987 a questionnaire was sent to all park units. Most have responded, and, of these, 63 sites show potential to have historic varieties of fruit or nut trees, dating from as early as 1752. Varieties in some Indian sites may prove to have an even earlier origin.

To adequately protect our nation's biological diversity, we need to know how good a job we already are doing. That is the goal of the Man and the Biosphere Program project, partially supported by the National Park Service. The project is designed to assess gaps in the representation of ecosystems in the nation's protected areas and to determine the degree of protection of these ecosystems. Researchers at the University of Colorado and Florida State University are developing this information, using digital base maps provided by the U.S. Geological Survey, existing ecological classifications, and maps of protected area systems. A report was prepared during 1987 on representation of major ecosystems in the national park system and other federal land management systems, and was published in The National Park System Plan: Blueprint for Tomorrow, National Parks and Conservation Association, 1988. A more detailed assessment of gaps in the national park system, and results of a pilot project in Florida will be the next outputs.

The ability of parks to maintain the biological diversity within them is strongly influenced by adjacent land uses. Conditions on either side of a park boundary, and their effects on species and natural communities, may vary greatly from one part of a boundary to another. A concept for a "boundary model" was developed by Christine Schonewald-Cox and her colleagues at the University of California-Davis NPS/CPSU. The next step is to develop and test the model, in col-

laboration with the NPS Geographic Information Systems Division, researchers at a number of universities, and participating parks.

A subsidiary project to measure boundary effects is already underway at Organ Pipe Cactus National Monument in Arizona, through a contract with the Arizona Nature Conservancy. Essentially four-sided, the monument is next to the undisturbed desert scrub lands of Cabeza Prieta National Wildlife Refuge on one side, desert scrub with grazing on two sides, and intensive agriculture along the border with Mexico. A vegetation map made in 1976 will be compared with aerial photography .62 mile on either side of the monument boundary taken in 1987. On the ground, researchers will record the degree of incursion of exotic plants into the monument and other effects traceable to outside influences.

Cooperation with other land managers will be an essential part of the NPS biological diversity program, because no single organization can do the job alone. Nature transcends human boundaries.

*Bill Gregg
Wildlife and Vegetation Division*

As the nation's principal conservation agency, the Department of the Interior has basic responsibilities to protect and conserve our land and water, energy and minerals, fish and wildlife, and parks and recreation areas, and to ensure the wise use of all these resources. The department also has major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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